TECHNICAL BULLETIN No. 48 FEBRUARY, 1928

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

THE WESTERN CEDAR POLE BORER OR POWDER WORM

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INTRODUCTION

Hundreds of the finest standing trees of the western red cedar or giant arbor vitae (*Thuja plicata* Don.) in the Pacific coast region of Oregon, Washington, and British Columbia have a large proportion of their timber riddled by the flattened, oval worm holes of the western cedar pole borer or powder worm (*Trachykele blondeli* Mars.). These holes wind through the sapwood and heartwood of the main trunk of infested trees and render the timber almost worthless for the higher grade uses, such as shingles, cooperage, doors, furniture, finishing, cabinetmaking, shipbuilding, and other high-grade products, for which it is otherwise especially suited. Worm holes do not seem to injure cedar timber seriously for use for fencing, sills, posts, piling, poles, or other construction purposes. Worm holes in timber, however, give it the appearance of being damaged, and, even if it is just as good as sound timber for certain purposes, the price is lowered and the manufacturer suffers a real loss.

[1] The writer is under obligations to the following fellow workers for assistance in the investigations treated in this bulletin: E. C. Van Dyke, S. A. Rohwer, Ralph Hopping, and W. S. Fisher for suggestions on classification; W. J. Chamberlin for the loan of specimens of the beetle; George Hopping for specimens of the larvae; J. H. Baxter & Co. for specimens of the work of the borer; A. G. Böving for a critical review of the larval descriptions and drawings; and Miss E. T. Armstrong for the drawings of the insect. The drawings of the work were made a number of years ago by the late J. F. Strauss.

HISTORY

As will be seen by the following history as recorded in literature, the western cedar pole borer or powder worm (*Trachykele blondeli* Mars.), as now recognized by taxonomists, is one of a group of five more or less closely related species which form the genus Trachykele of the family Buprestidae (flat-headed borers) of the order Coleoptera (beetles).

The genus Trachykele, with the species *blondeli* as the type, was named and described by Marseul (*32*)[2] in 1865 from a specimen said to have been found in the Custom House at Paris, France, by M. Blondel. The specimen was supposed to have emerged from the wood of a cedar of Lebanon.

Gemminger and Harold (*17*) listed the species in 1869 with the locality New Orleans, and placed with it in the genus Trachykele the species *Dicerca lecontei*, which had been listed by Dejean (*14*) in 1837, described by Gory (*19*) as *Buprestis lecontei* in 1841, and mentioned by Leconte (*27*, *28*, *29*) as *Buprestis lecontei* in 1858 and 1859, and as *Dicerca lecontei* in 1863.

Saunders (*34*) in 1871 changed the locality of *blondeli* to Mexico. Crotch (*12*, *13*), writing in 1873, said the species appeared to be North American and might be the same as *Dicerca lecontei* Gory. He listed both species under the genus Trachykele in his check list. Stein and Weise (*35*) in 1877 gave Georgia as the locality for *blondeli* and said that the species was introduced into Europe. Waterhouse (*36*) in 1882 figured *blondeli* for the first time and stated that it was said to come from Mexico, but expressed some doubt about that locality. LeConte and Horn (*30*), in their "Classification of the Coleoptera of North America" published in 1883, gave characters for separating Trachykele from other members of the group Buprestes.

Heyden, Reitter, and Weise (*23*) listed *blondeli* from Georgia in 1883 and noted that it had been introduced into Europe. Henshaw (*21*) in 1885 considered the species to be North American. Kerremans (*24*, *25*, *26*) stated in 1892 that *blondeli* Mars. is the same as *lecontei* Gory and that the habitat is Mexico, and repeated his statements in 1903 and 1904. He gave no evidence for his positive statements and said he had never seen either species. Hamilton (*20*) wrote in 1894 that the species *blondeli* had been omitted from the latest European catalogue because it did not successfully acclimate in Europe when introduced.

Wickham (*37*) in 1902 recorded *lecontei* from Garland, Colo., and Blaisdell in 1903 from Tulare County, Calif. Fall (*15*) in 1906 questioned the localities of Mexico and New Orleans and recorded specimens of *blondeli* from Santa Fe, N. Mex. He gave a complete review of the genus and described two new species, *opulenta* close to *blondeli*, and *nimbosa* close to *lecontei*. Fall and Cockerell (*16*) listed *blondeli* from Santa Fe, N. Mex., in 1907. Wright and Coolidge (*38*) in 1908 listed *opulenta* from Placer County, Calif.

The present writer noted in 1908 that all the species of Trachykele apparently live upon cedar of some kind; and in later papers (*1*, *2*, *3*, *4*, *5*, *6*, *7*) he described for the first time the larvae and work of

[2] Reference is made by italic numbers to "Literature cited," p. 14.

blondeli, *lecontei*, *opulenta*, and *nimbosa*, described a new species, *hartmani*, and recorded numerous observations on the distribution, habits and host plants of the various species. Casey (*8*), writing in 1909, gave "Pacific coast to Gulf of Mexico" as the distribution for the genus Trachykele.

Gibson (*18*) reported *blondeli* from Goldstream, B. C., in 1914, and Chrystal (*11*) reported it in 1917 as a destructive wood borer of green and dead cedar in British Columbia. Chamberlin (*9*) in 1917 noted the occurrence of *opulenta* and *nimbosa* in northern California, and in 1924 (*10*) reported serious damage by *blondeli* to cedar in western Oregon. Herbert (*22*) in 1920 recorded *blondeli* as an associate of the cypress bark scale, *Ehrhornia cupressi* (Ehrhorn), on Monterey cypress. Leng (*31*) in 1920 listed *opulenta*, *blondeli*, *nimbosa*, and *lecontei* from North America, and Nicolay (*33*) in 1921 recorded *hartmani* in his list of new North American beetles.

ECONOMIC IMPORTANCE

Supervisor G. T. Allen of the Mount Rainier National Forest, in a letter to the Forester dated June 11, 1905, said: "A very large part of the cedar (in this forest) is worm eaten." Again on June 29, 1905, in a letter to Doctor Hopkins, he wrote: "The worm eaten trees often are green and apparently thrifty when the timber is so full of holes as to be of little value." And again on July 12, 1905: "I think it very possible that the insect does not attack living trees, but the holes are very common in both green and dead timber not long after the tree has been felled. As the timber is spoiled for shingles and most other purposes; and, as the insect appears to be common in certain localities on this reserve and its vicinity, I should like to be informed of its name and whether it attacks the living trees."

In June, 1905, a shingle man near Portland, Oreg., sent in shingles from cedar heartwood, which were badly riddled by the flattened oval worm holes. (Fig. 2.) He reported a large amount of timber severely damaged.

During the same year the shingle men at a mill at Hoquiam, Wash., struck because so much of the timber that they had to handle was worm eaten. As they worked by piece work, all of the worthless stuff that went through their hands was a direct loss to them, representing that much time thrown away.

In Pialschie, Wash., in 1906, the writer found the mines numerous in both the sapwood and heartwood of standing dead and living trees, and in piling used for a railroad bridge.

In 1912 B. T. Harvey reported that in the lower Columbia River Basin in Oregon worm holes often reduce from 30 to 50 per cent of the best grades of cedar to lower-grade material. Sometimes fully 70 per cent of the tree is entirely destroyed as far as its value for shingles is concerned.

During 1914 and 1915 the writer found many juniper trees in the Lake Tahoe section of California with the wood of the trunks badly riddled by the worm holes of this species. As the juniper has a probable value as a producer of pencil wood, this damage in time may become the deciding factor in determining its commercial value.

In 1917 Chrystal (*11*) reported worm holes as a source of considerable loss to both green and dead cedar in British Columbia. In 1924 Chamberlin (*10*) wrote that the work of the borer was common in Oregon from the coast up to about 2,000 feet elevation, and that some shingle manufacturers estimated their loss at from 15 to 30 per cent of the cut on limited areas.

During the last few years manufacturers of cedar poles in Washington and British Columbia have reported numerous cases of wormy timber and have requested information on the habits of the worm causing the damage.

DISTRIBUTION

Trachykele blondeli has been recorded from the following localities: Lebanon, Turkey (Marseul); New Orleans, La. (Gemminger and Harold); Mexico (Saunders) (Waterhouse) (Kerremans); North America (Crotch); Georgia (Stein and Weise) (Heyden, Reitter, and Weise); Santa Fé, N. Mex., Mexico, and New Orleans, La. (Fall); Santa Fé, N. Mex. (Fall and Cockerell); British Columbia, Washington, Oregon, California (Burke); Oregon (Chamberlin); and British Columbia (Gibson) (Chrystal).

There are specimens in the United States National Museum from Corvallis, Oreg. (Cordley); Hoquiam, Wash. (Burke); Palo Alto, Calif. (Burke); and Strawberry (Placerville), Calif. (Burke); and in the forest-insect collection of the Bureau of Entomology from Pialschie and Hoquiam, Wash. (Burke); Orting, Wash. (Smith); Portland, Oreg. (Currie); Scappoose, Oreg. (Harvey); Placerville, Los Gatos, and Echo Lake, Calif. (Herbert); Vade, Calif. (Burke and Herbert); San Geronimo, Calif. (Herbert and Hartman); Ignacio, Calif. (Hartman); Siskiyou Mountains, Calif. (Miller and Sergent); and Pender Harbor, B. C. (George Hopping).

It seems probable that all of the localities recorded in the earlier literature are questionable owing to the fact that the habitat of the type specimen which was obtained at the Custom House at Paris, France, was never accurately determined.

The species as at present considered ranges in altitude from the cedar and cypress at sea level to the juniper at 7,500 feet.

FOOD PLANTS

Trachykele blondeli Mars. was first reported (*32*) as living in the wood of the cedar of Lebanon (*Cedrus libani* Loud.), the first specimen being taken from some cedar which was supposed to be that species. This, however, was probably the wood of some American cedar, for all of the succeeding specimens have been collected in North America. The forest-insect collection of the Bureau of Entomology contains specimens from the western red cedar or giant arbor vitae (*Thuja plicata* Don.), Monterey cypress (*Cupressus macrocarpa* Hartw.), Sargent cypress (*C. sargentii* Jep.), McNab cypress (*C. macnabiana* Murr.), western juniper (*Juniperus occidentalis* Hook.), and a single adult from the incense cedar (*Libocedrus decurrens* Torr.).

CHARACTER OF THE INJURY

Injury by the western cedar pole borer is characterized by flattened, oblong, oval worm holes or mines, 9 to 14 mm. wide and 3 to 4 mm. deep, which wind tortuously back and forth and up and down from several to many feet through the wood of infested trees. (Fig. 1.) The holes usually follow the layers of the wood either vertically or transversely, but often the worms cut through these layers to get closer to the surface or nearer the heart. Most of the holes are filled with ovo-cylindrical pellets of excrement closely packed in with the chewed borings. Both pellets and borings are of the same color, and are packed tightly together so that it is sometimes hard to distinguish any difference between them. The surface of the wood surrounding the holes is marked by curved grooves made by the mandibles as the head of the worm moved from side to side in boring. Each completed mine terminates in an enlarged portion, the pupal cell, which connects with the outer surface by an oval exit hole an inch or more long, made by the adult when emerging.

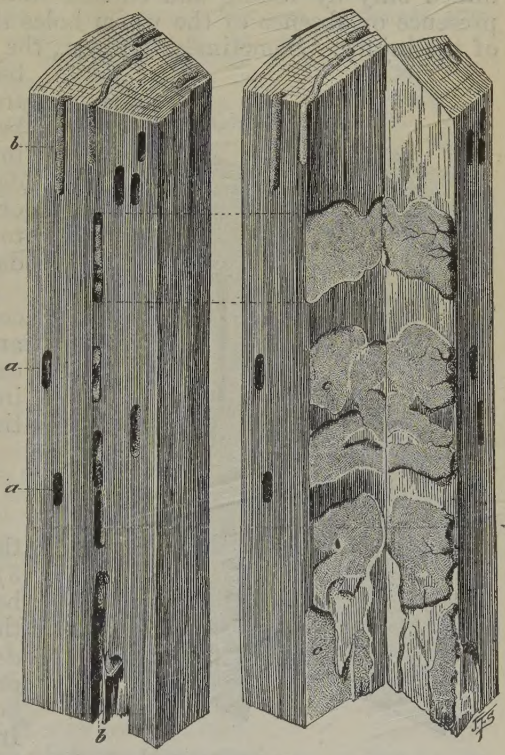

FIG. 1.—Larval mines in wood of trunk of western red cedar (*Thuja plicata*), made by larvae of *Trachykele blondeli*: *a*, Cross section of larval mine; *b*, longitudinal section; *c*, tangential section

The borings in juniper often differ from those in cedar. The egg is laid on a small branch and the larva mines down the branch to the trunk and back and forth in the trunk until it becomes full grown, when it again mines out in a branch to pupate and transform to the beetle. Juniper trunks are often just a mass of worm holes.

In staves, shingles, or any quarter-sawn stuff (radial section) the injury shows as oblong, oval, flattened holes which usually extend through the piece. (Fig. 2, *c*.) The holes are from 3 to 4 cm. wide and from 9 to 100 cm. long, depending on whether the mine was cut crosswise or lengthwise. They ruin staves, shingles, boat strips, or shiplap, where tightness is required, and cause serious defects in door furniture, and finishing stock, which should be free from all blemishes.

In lumber or other bastard-sawn timber (tangential section) rough irregular grooves, or rather large unsightly patches of borings, are caused, which reduce the value of the timber for the higher grade uses. (Fig. 2, *b*.)

INDICATIONS OF INJURY

Usually there are few, if any, outward indications of wormy timber. The absence, or presence, and extent of injury can be determined only by felling and cutting into the tree in question. The presence or absence of the worm holes then will indicate the extent of the injury. Sometimes, however, the oval exit holes made by the beetles in emerging from the tree can be seen in the outer bark or wood, and indicate injury within. Dead tops, dead branches, or bare spots on the trunk, are good places to look for these evidences of damage.

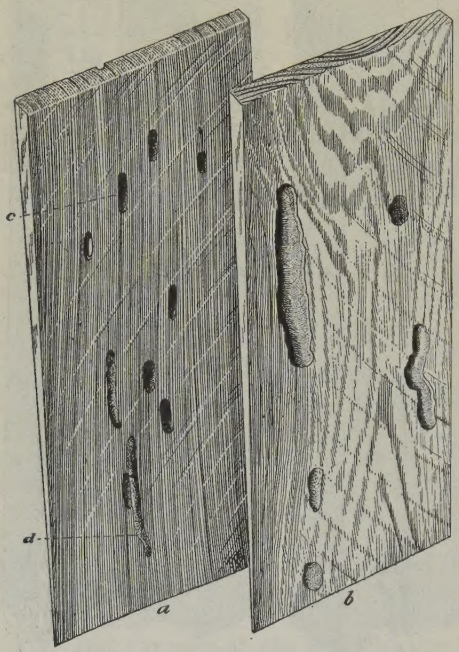

FIG. 2.—Western red cedar shingles badly damaged by larval mines of *Trachykele blondeli*: *a*, Quarter-sawn shingle showing both cross and longitudinal sections, *c*, *d*, of the larval mines; *b*, bastard-sawn shingle showing same

As the injury usually is common in certain localities and absent in others, the locality is very often a good index to the liability of the timber being sound or injured.

CAUSE OF THE INJURY

The cause of the injury is the larva, grub, or borer (fig. 3) of a bright velvety green beetle (fig. 4) belonging to the species *Trachykele blondeli* Mars., of the family Buprestidae (flat-headed wood borers). The borer hatches from an egg laid by the female beetle on, or near, the wood of a scar on the trunk, top, or branch of a living tree. Upon hatching the borer mines down into the wood and, if in top or branch, through it to the trunk. Then it winds back and forth and up and down through the trunk for many feet, until it becomes full grown. It then mines back to a branch or to the wood of a scar, where it forms a cell and rests awhile. Finally it goes through a chrysalislike pupal stage and transforms to a beetle. This beetle rests in its wooden cell for about eight months. In April or May it gnaws its way out of the cell to the surface of the tree and flies away to meet others of its kind and mate.

DESCRIPTION OF THE INSECT

ADULT

(Fig. 4)

Marseul (*32, p. 150–151*) described *Trachykele blondeli* as follows (free translation):

1. Blondeli. Length 20—breadth 7 mill.

Elongate oval, slightly convex, of a rather brilliant bronzy green color, densely reticulate punctate above, rugosely punctate anteriorly, dotted underneath posteriorly and covered with a fine white pubescence. Antennae slim and long. Head swollen on the vertex, unequal at the front, with a sinuous transverse impression, grooved before the epistoma which is elevated and grooved at the end; eyes black, oval, rather small. Pronotum in a transverse square, compressed at both ends, cut straight anteriorly, with the angles depressed, straight, bisinuate at the base, with acute angles, bordered at the sides by a smooth, shining edge, arched and sinuate toward the base, hidden above posteriorly by a very much elevated ridge; marked by deep foveoles, one broadly oval, anteriorly, one small one before scutellum, separated by a smooth space on the median line and two others on each side. Elytra as wide at base as the base of pronotum, then abruptly enlarged and almost four times as long, slightly dilated under the shoulder, with very prominent callous; narrowly emarginate, subparallel for two-thirds the length, then narrowing toward the end to a blunt point; suture elevated posteriorly into a carina, furnished at the middle with three rows of foveoles, supplied with rather sparse black pustules, separated by three very irregular weak ribs. Prosternum rugosely punctate, swollen anteriorly, grooved longitudinally. Posterior coxae dentate at the middle of the posterior margin; first segment of the abdomen flat; terminal segment ending in a prolonged rounded point. Liban. (M. de Mniszech.)

FIG. 3.—Dorsal view of larva of *Trachykele blondeli*, ×3

The type evidently was a female, as the last segment is described as ending in a prolonged rounded point.

Waterhouse (*36*), in writing of the single specimen in the British Museum, says that the crests, ridge, and excavation on the thorax are distinct, there are three ridges on each elytron, there are six groups of the blackish spots, and the sides and tips of the elytra are purplish.

Fall (*15*), in his discussion of the species, says: "There is on each elytron of *blondeli* at about two-fifths from the apex and midway between the suture and side margin, a small transverse impunctate cariniform elevation or tumidity * * *."

The writer has before him 22 specimens supposed to be *blondeli*. Two females from Oregon were taken from western red cedar, 1 female from incense cedar; 1 female from Washington, and 1 female and 1 male from Oregon were caught flying; 4 females and 2 males from the coast of central California were taken from the cypress; and 4 females and 6 males from the Sierras of eastern California were taken from the western juniper. Five of these specimens are in the National Museum collection, 7 in the collection of W. J. Chamberlin,

and 10 in the collection of the Pacific slope laboratory of the division of forest insects of the Bureau of Entomology.

The specimens from the cedar are apt to be duller in color and darker than those from the cypress, which are apt to have coppery margins to the elytra and coppery markings on the thorax. The specimens from the juniper appear more delicate and more brilliant in coloring. They appear also to be slightly smaller, although the largest juniper specimens are larger than the smallest cedar and cypress specimens. Specimens from the cedar varied in length from 15 to 20 mm., those from the cypress from 15 to 19½ mm., and those from the juniper from 13 to 17½ mm.

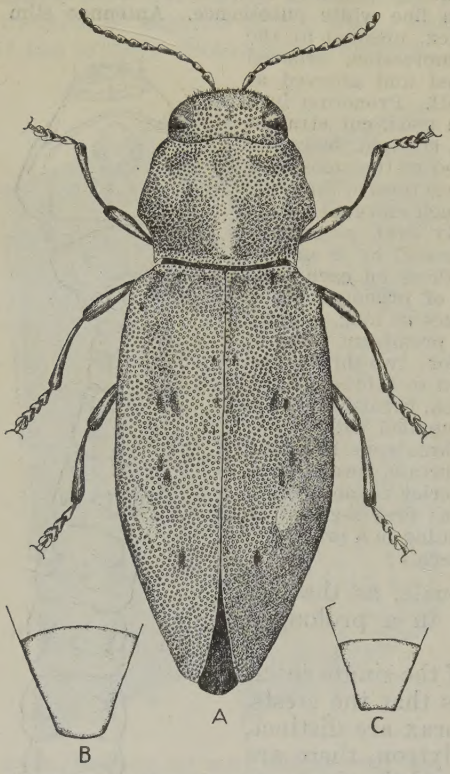

FIG. 4.—*Trachykele blondeli:* A, Dorsal view of male beetle, ×4; B, ventral view of last abdominal segment of female; C, ventral view of last abdominal segment of male

All of the specimens examined agree very well with Marseul's description and with the characters mentioned by Waterhouse and by Fall. None have been seen that have the deep foveoles on the pronotum separated by both a smooth space on the median line and two others on each side as mentioned by Marseul, nor with the sides and tips of the elytra purplish as given by Waterhouse. Usually the median line of the thorax is smooth, but there are no smooth spaces on the sides.

The last ventral segment of the female is rounded or angulate and that of the male is truncate. (Fig. 4, B, C.)

In the opinion of the writer the specimens from the juniper which range in the mountain districts of eastern California and probably in Nevada, Utah, Arizona, and New Mexico, should be separated as a subspecies from those that occur in the cypress and cedar along the coast of Oregon, Washington, and British Columbia. Accordingly this subspecies is described below.

TRACHYKELE BLONDELI JUNIPERI new subspecies

Similar to *blondeli*, except that the adults are more delicate and of a more brilliant green color.

Adult holotype, female.—Length, 17 mm. Last ventral slightly angulate.

Allotype, male.—Length 15 mm. Last ventral squarely truncate.

Type larva.—Similar to larva of *blondeli.*

Type locality.—Pyramid Ranger Station (Strawberry), Eldorado County, Calif.

Described from four females, six males, and numerous larvae collected from the foliage or the wood of the western juniper (*Juniperus occidentalis*) near the Pyramid Ranger Station and at Fallen Leaf, Calif., by the writer, F. B. Herbert, and W. J. Chamberlin. Other specimens have been collected in the vicinity of Fallen Leaf Lake by E. C. Van Dyke, E. P. Van Duzee, and Ralph Hopping. Elevation 6,500 to 7,500 feet.

Holotype, allotype, paratypes, and type larvae.—Cat No. 29072, U. S. Nat. Mus.

Paratypes in the collections of the California Academy of Sciences, W. J. Chamberlin, and the Pacific slope laboratory of the division of forest insects of the Bureau of Entomology.

EGG

The egg has not been observed. It probably is oblong oval, smooth, and light colored like those of closely related species.

MATURE LARVA

The larva is described from three specimens marked "From *Thuja plicata*, Pender Harbor, B. C., Coll. G. R. Hopping, 16478a"; two specimens, "16471a, April 14, 1925, Everett, Wash., cedar telephone pole"; three specimens, "1103a, Jan. 3, 1913, Scappoose, Oreg., red cedar"; all specimens being deposited in the United States National Museum.

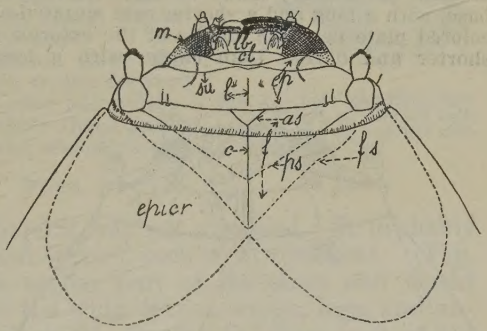

FIG. 5.—Dorsal view of head of larva: *as*, Anterior rod-shaped thickening in frons; *c*, carina of frons; *cl*, clypeus; *ep*, epistoma; *epicr*, epicranium; *f*, frons; *fs*, frontal suture; *l*, longitudinal dark line of epistoma; *lb*, labrum; *m*, mandible; *ps*, posterior rod-shaped thickening in frons; *su*, sulcus of epistoma. ×13

Thorax broad and flattened; abdomen slender, about half as broad as thorax and subcylindrical; texture finely roughened, dull, whitish; pubescence sparse, light colored; length 30 to 35 mm., greatest width 7 to 8 mm.

Head (figs. 5 and 6) subcordate, posteriorly deeply emarginate, for the greater part retracted into prothorax and thinly chitinized, epistoma and mouth parts darker.

Frons *f* well developed, subtriangular, anteriorly with large epistoma, laterally poorly defined by almost vanishing frontal sutures *fs*, posteriorly reaching to the occipital foramen; epistoma *ep* anteriorly with front margin slightly inward-curved in the middle and forward-rounded on both sides, posteriorly sharply defined from rest of frons by a straight border line, behind the front margin, with a transverse, biarcuate, backward-bent sulcus *su* and on the underside with circular articulation of great size for each mandible; general color brownish yellow medianly with a dark longitudinal line *l*, on each side of this line a bisetose epistomal pit; frontal carina *c* distinct, present in the middle line from hind margin of epistoma to hind corner of frons, with one pair of short, straight, diverging, rod-shaped thickenings *as* extending from anterior part of carina to hind margin of epistoma, and another, limpid, much longer pair of similarly diverging, straight, rod-shaped thickenings *ps* from posterior part of carina to each end of epistoma; one large and one short seta near basis of antenna immediately behind posterior border of epistoma. Clypeus *cl* transverse, lanceolate, four times as broad as long. Labrum *lb*

subtrapezoidal, about three times as broad as long, broadest in front, anterior angles rounded, anterior margin slightly emarginate, armed with a fringe of light-yellow setulae, one large seta situated near each antero-lateral margin. Antenna three-jointed, basal joint large, subconical, second joint about as long, subcylindrical, distal margin finely fringed, third joint very small, telescoped into the tip of the second, bearing a long, lateral, subdistal bristle, tip fringed.

Mandible (fig. 7) broad, quadrangular, with bicarinate, concave inner face, distal third piceous, distinctly three-toothed with a retinaculum r_1 and r_2 on both the dorsal and ventral inner margins; two large bristles on the outside of the basal section.

Peristoma *p*, the lateral part of the mouth frame between the dorsal and ventral mandibular articulations, well developed, posteriorly limited from genae by a sharply projecting chitinous wall with a long bristle at each end. Hypostoma *h*, the ventral part of the mouth frame inside of the ventral mandibular articulation, with anterior corner toward gula dark colored.

Ventral mouth parts retracted; maxillary articulating area not developed. Maxilla prominent; cardo *ca* light colored, large, subtrapeziform, broader at base, with a long and a shorter seta situated closely together on a minute dark-colored plate near the middle of the exterior margin; stipes *s* slightly clavate, shorter and darker than cardo, with a long distal bristle; mala (possibly galea) *ma* single, jointlike, movable, not fully as long as first joint of palpus and about half as wide, somewhat flattened, cuneiform, broadest in front and here obliquely rounded, inner margin setose; maxillary palpas *pa* about as long as inner margin of stipes, two-jointed, first joint cylindrical, twice as long as wide, with a long distal bristle, second joint conical, somewhat shorter than width of first joint, half as wide as long. Gula *gu* narrow, darker anteriorly. Submentum *sme*, probably with mentum incorporated, triangular, wedged in between the cardines. Labium, composed of the fused short eulabium *el* and large, anteriorly rounded ligula *li*, subtrapezoidal, half as long as broad, anterior angles rounded, anterior margin slightly emarginate, fringed; labial palpi vanishing, one-jointed, a long bristle situated inside of each palpus, near posterior angles.

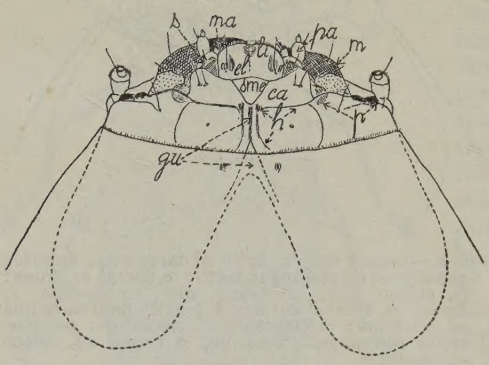

FIG. 6.—Ventral view of head of larva: *ca*, Cardo; *el*, eulabium; *gu*, gula; *h*, hypostoma; *li*, ligula; *m*, mandible; *ma*, mala (possibly galea); *p*, peristoma; *pa*, maxillary palpus; *s*, stipes maxillae; *sme*, submentum (possibly with fused mentum). ×13

Prothorax large, obcordate, dorsal and ventral plates well developed, coriaceous and granulose; posterior half of dorsal plate marked by two paramedian grooves, together forming a figure like an inverted V, having immediately in front of them in the anterior half a large, median, unpaired, oval and shining depression; ventral plate (fig. 8) marked by a broad, median, shining groove occupying the posterior two-thirds of the plate, with a broader, oval, shining depression at its anterior end, the whole forming a torchlike marking; on each side of the median groove a smaller, round and shallow depression situated at the posterior margin of the plate in a distance from this equal to about one-third of the entire distance between the posterior and anterior margins.

Mesothorax somewhat narrower than prothorax, short, laterally divided into two lobes by a deep, vertical groove continued in a transverse horizontal groove on the ventral side of the segment; mesothoracic spiracle situated in the anterior lobe; a chordotonal chitinous spot present at the end of the vertical groove in considerable distance from the spiracle.

Metathorax slightly broader and more than twice as long as mesothorax, the length being about one-third of the width. A chordotonal chitinous spot present in a place corresponding to that of mesothorax.

First abdominal segment more intimately connected with metathorax than with second abdominal segment, broadest anteriorly, shorter than the follow-

ing segments and without any distinct epipleural folds or pads; tergum and sternum with a shieldlike, slightly coreaceous, unpaired, oval scansorial area, larger than those of the following segments; spiracles placed in lower, anterior corners of tergum.

Second to eighth abdominal segments, subcyclindrical, with a scansorial area developed on terga and sterna of all segments as a median, unpaired, transverse elliptical ampulla; epipleural folds distinct, with elongate subrectangular bases; spiracles placed in lower anterior parts of tergum above the epipleural folds, in about one-fourth of the distance from the anterior to the posterior margin of the segment.

Ninth abdominal segment somewhat narrower and slightly shorter than the preceding segment, broadest anteriorly, with trace of pleural folds and dorsal and ventral scansorial ampullae.

Tenth abdominal segment porrect, narrower but as long as ninth segment, membranous, conical, posteriorly divided into two short, fleshy, lateral anal lobes. Anal opening linear, vertical.

Spiracles lateral; spiracular cribrate plate elongate reniform, with concave margin facing forward both in mesothorax and abdomen; color pale yellowish brown; mesothoracic spiracle three times longer and correspondingly wider than the abdominal.

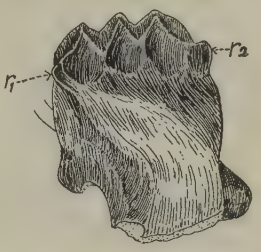

FIG. 7.—Left mandible, buccal view; r_1, Dorsal retinaculum; r_2, ventral retinaculum. ×32

PUPA

The pupa of *Trachykele blondeli* was not obtained. It probably resembles those of closely related species, such as *T. opulenta.* (Fig. 9.) It would be white in the earlier part of the stage and would resemble the adult, except that the wing covers, wings, legs, and antennae would be folded on the breast. During the later part of the stage it would take on more of the adult coloring. The pointed head characterizes all of the Trachykele pupae observed by the writer.

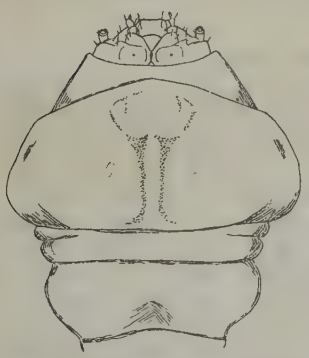

FIG. 8.—Ventral view of head and thorax of larva. ×4

LIFE HISTORY

During its lifetime the western cedar pole borer or powder worm passes through four distinct stages: The egg, larva, pupa, and adult. The egg stage probably is passed on the surface or in a crevice in the wood of its host tree. Part of the larval stage, the growing period, is passed in a mine in the wood of the trunk or of a branch, and part, the resting period, in a cell at the end of the mine in the outer wood beneath a scar on the trunk or in the wood of a branch. The pupal stage is passed in the cell made in the wood by the larva. The adult spends the earlier and greater part of its life in the pupal cell in the wood and the latter part on or about the bark, wood, or foliage of the host tree.

HABITS

The adults emerge from the infested timber and fly away to fresh trees, to other parts of the same tree, or to some food plant, where they mate. No observations have been made on their food habits, but they probably feed on the leaves of trees as do some of their

near relatives. One of the specimens taken was flying, another was resting on a fence in a sawmill town, a third was caught in a wood cellar, and the fourth was beaten from the foliage of a juniper. They probably live throughout the summer. Adults kept in cages lived between 30 and 40 days.

Oviposition has not been observed, but the beginnings of the larval mines tend to show that the eggs are laid in or under the bark where it is cracked or peeled off. The eggs soon hatch and the young larvae begin their career of destruction.

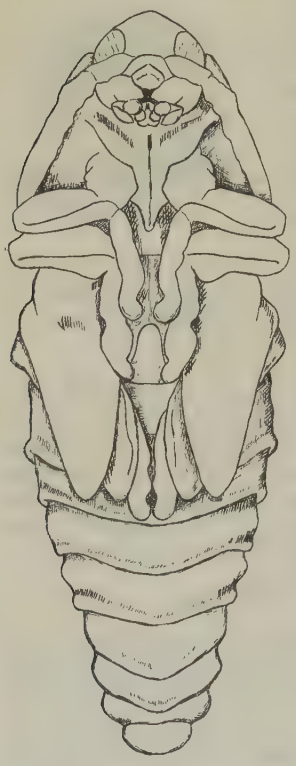

FIG. 9.—Ventral view of pupa of *Trachykele opulenta*, which is representative of the pupae of species of Trachykele. ×5

The mine is started in the outer wood. The larva eats out a nearly flat oval hole as it moves from side to side in a regular curve which marks all the surface. As it goes along it packs the borings and excrement tightly in the mine behind it, sometimes in the form of a homogeneous mass, at other times in the form of little elongate, oval pellets. Sometimes the mine is excavated straight along with the grain between two layers of the wood; at other times it goes straight across it or obliquely through it. It winds here and there, from outer surface to heart and back again, large mines having been found on the outer surface. Usually the mine terminates in the sapwood near the outer surface, where the larva recedes a little, pupates, and transforms to an adult, which rests over the winter and gnaws its way out in the spring.

SEASONAL HISTORY

Very little is known of the seasonal history of *Trachykele blondeli*. Adults were collected flying at Palo Alto, Calif., in April, 1905; at Corvallis, Oreg., on May 19, 1897; at Hoquiam, Wash., on June 2, 1905; and at Pyramid Ranger Station, Calif., on June 28, 1915. Adults were collected in their pupal cells in the wood at Pyramid Ranger Station, Calif., on August 27 and September 10, 1924, and October 21, 1915; Los Gatos, Calif., November 30, 1917; near Placerville, Calif., December 22, 1917; and at San Geronimo, Calif., April 8, 1919. Various sized larvae are found in the wood at all seasons of the year.

The observations indicate that the insect passes the winter in the wood, either as a small or a large larva in the larval mines, or as a young adult in the pupal cell. The larva probably feeds all winter, but it may remain dormant during especially cold periods or in localities with a cold climate.

Activity commences in the spring with the active feeding of the larva or the emergence of the adult. The date of emergence varies according to latitude, altitude, climate, and local weather conditions.

Oviposition takes place in the late spring or summer.

The larva takes at least two years to reach full development, passing the first winter as a small larva and the second as a large one.

Pupation takes place the third summer or fall, transformation to the adult the third fall, and emergence of the adult the fourth spring.

The life cycle appears to be as follows: Adults emerging in the spring, ovipositing in summer, eggs hatching to young larvae in summer; larvae living over the fall, winter, second spring, and second summer, become large; live over the second fall, second winter, third spring, and third summer, pupating and transforming to the adult the third fall; adult wintering over third winter in the pupal cell and emerging fourth spring.

There is thus at least a three-year cycle, which may account for the rarity of the adult as compared with the commonness of the larval work.

NATURAL ENEMIES

As far as known, *Trachychele blondeli* has very few natural enemies. Since the larval work is very common while the adult insect is so rare, it would seem there must be something that is very destructive to it in the later stage of its development.

Large larvae of the trogositid beetle *Temnochila chlorodia* (Mann.) were common under the bark and in mines in the wood of the red cedar at Pialschie, Wash., in September, 1905. These appeared to prey on the *blondeli* larvae which infested the wood.

No indications of parasites or diseases were noticed during the observations made by the writer on this species.

METHODS OF PREVENTING LOSS

Since most of the damage is done while the tree is alive, and is present in the affected timber when it is cut, the only methods which appear to be available for preventing losses are those which utilize the damaged stuff to the best advantage.

Wormy timber should be used for poles, posts, planking, sills, or other material in cases where clearness and tightness are of no particular importance and where wormy timber is practically as good as sound stuff.

It should not be used for cooperage, boat building, furniture, shingles, or cabinetmaking, in which case clear, sound stuff is essential.

Those who wish clear, sound material should use great care in buying. Often logs that are clear of knots and otherwise first class are riddled with worm holes. Most of the material from some localities is wormy, while none of that from other localities is. If wormless timber is desired, it will be safer to buy timber from a district that is known to be free of Trachykele.

SUMMARY

The wood of many standing trees of western red cedar in Oregon, Washington, and British Columbia is severely injured by flattened oval worm holes which render it unfit for the higher grade uses.

The cause of these worm holes is the larva (flat-headed borer) of a brilliant greenish beetle (*Trachykele blondeli* Mars.) which belongs to the coleopterous family Buprestidae.

The beetle lays its eggs on the wood of scars on the trunk or branches of standing trees, and the borers hatching from the eggs mine up and down through the wood of the trunk until they become full grown, which apparently takes at least three years. The borers then transform to beetles, which remain in the wood for about six months, when they emerge and start a new generation.

Under present conditions of forest management the only method of controlling loss which appears practical is to use the injured material for purposes for which it is best suited. Apparently the worm holes do not seriously injure cedar timber for use as fencing, sills, posts, poles, or other construction purposes. They do make it worthless for shingles, cooperage, shipbuilding, and other special purposes where tight or unblemished material is required.

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